tion were greatly increased. In the early seventies the necessity of linking the coastal stretches with the commercial telegraph systems of the country was an outstanding problem for the Army Signal Service. A beginning was made in New Jersey where the first unit of what was for many years known as the "sea coast" line was constructed between Seaville and Pecks Beach, N. J., a stretch of but 10 miles. Immediate steps then were taken to construct a line along the beach of the New Jersey coast from Sandy Hook to Cape May Point and later to extend that line to Smithville, N. C. The line was finished in about a year and functioned successfully for many years; the section from Cape Henry to Hatteras, N. C., now transferred to the Coast Guard was a part of the original construction. The line was operated directly from the signal office in Washington, D. C., and had for its purpose the display of storm warnings in the interest of coastwise as well as of across-seas traffic. Another factor in its use was the succor of vessels in danger of foundering or in distress. Communication between ship and shore was had by means of the international signal flags and by visual signalling in the rare cases when a Signal Service man boarded a vessel in distress and wished to communicate with shore.

Military telegraph lines in the interior, as from time to time, authorized by Congress were for the most part constructed by troops detailed for that purpose. Among the first, if not the very first line so constructed, was one joining San Diego, Calif., by way of Fort Yuma and Maricopa Wells, Ariz., with Prescott and Tucson. This construction was followed by a survey and preliminary work looking to the building of lines connecting military posts in Texas, of which at that time there were 10 or 12. Some of them were along the Texas-Mexico boundary, one was in the Texas Panhandle and others were more or less distant from the advance posts of settlement. To connect these points and other places along the border required a greater outlay of time and labor than had hitherto been expended in any single State.

Concurrently with the activity in Texas, building new lines and extending those already built both in Arizona and New Mexico also in the far Northwest was being carried on.

The longest stretch of line when single units were joined together was that extending from San Diego, Calif., to Denison, Tex., as an eastern terminal. The present writer, when stationed at the last-named point in 1879, well remembers making a number of attempts to work with San Diego, but without success due, no doubt, to the poor insulation of the line in places. Ordinarily the attempt to work long stretches of the military lines as a single circuit was not made. The Texas lines of a total length of more than 1,500 miles were operated as a single circuit three times daily in the collection of meteorological reports from the stations on those lines. At other times they were operated as two or three separate circuits.

Several causes were responsible for the gradually dwindling mileage of the military telegraph lines from its peak of 5,114 miles in 1882 to 1,025 miles in 1891. These causes, named in the order of their importance were, (1) appeals to Congress for increased appropriations for their maintenance were only partially realized, (2) the custom of detailing enlisted men from the Regular Army as operators and linesmen failed in 1883, (3) the abandonment of military posts naturally resulted in the sale or dismantling of the line if local interests were not sufficiently great to warrant its maintenance as a private venture.

In 1883, the year after the peak was reached 2,450 miles of line were sold or abandoned and eight years later when the meterological activities of the Army Signal Service were transferred to the newly created Weather Bureau in the Department of Agriculture but 1,025 miles of the original 5,114 remained. Only those sections that were vital to the meteorological service were continued in use by the Weather Bureau. The new construction by that bureau amounted to a total of 270 miles of land lines and submarine cables; that mileage plus the 629 miles inherited from the Signal Corps makes a total of 899 miles all of which has now been disposed of either by sale or transfer as noted in the beginning of this article.

EFFECT OF CLOUDS ON THE SURFACE TEMPERATURE

551.576 : 551.524

By W. J. HUMPHREYS

Obviously the radiation emitted by and from any portion, large or small, of the surface of the earth tends to come into equilibrium with the radiation simultaneously absorbed by the same surface. Clearly, too, this exchange, though generally equal only twice in the course of a day and night, would, on the average, balance perfectly (neglecting the minute supply of heat from the interior of the earth) if there were no conduction to and from the atmosphere, nor vertical or horizontal motion—convection and advection—of the air or the oceans, nor evaporation or condensation. But all these things do occur and they greatly disturb the radiation balance. However, they are roughly the same whether the sky be clear or cloudy, and therefore may be disregarded in computing a first approximation to the effect of clouds on the surface temperature.

The rate of emission per unit projected, or minimum inclosing, area is a function of the material and mechanical condition, rough or smooth, of the surface (reentrant angles producing a closer approach to the full radiation) its temperature (directly proportional, nearly, to the fourth power of the absolute temperature), and to the barometric pressure, varying directly as the square of the refractive index of the adjacent air. This latter effect is negligible, since the refractive index in question differs very little from unity. The rate of this radiation does not, however, depend at all on the state of the sky, such as clear or cloudy.

On the other hand, the rate of absorption by the given radiating surface does depend, and very greatly, on the state of the sky owing to the consequent large variations in the amount of incident radiation that might be absorbed. It also, like emission, is a function of the material and condition of the surface and of the barometric pressure.

In general, except as prevented by winds, convection and evaporation, the temperature of the surface tends rapidly to become such that emission is equal to absorption. Furthermore, the greater the rate of incident radiation the greater, in substantially the same ratio, the rate of absorption and the higher the surface temperature.

Let—

S = the net radiation received (incoming less outgoing) per unit horizontal area during a clear night.

S' = the net radiation similarly received from sun and during a clear day.

C = the net radiation received per similar area from a low cloud canopy by night.

C' = the net radiation received per like area from a low cloud covering by day.

Evidently, then, if, as assumed, we may neglect everything but radiation and absorption, and consider the coefficient of absorption to be the same whether the sky be clear or clouded, the effect of a sheet of clouds is to lower the surface temperature, to leave it unchanged, or to raise it, according as $S+S'$ is greater than, equal to, or less than $C+C'$.

From observations by Kimball,[1] we know that throughout the night, and for the latitude of Washington, D. C., the net outgoing radiation is, when the sky is clear, 0.15 calories, roughly, per minute per horizontal square centimeter, and 0.05 calories when the sky is covered with clouds.

Furthermore, from observations, $S=5\,C$, roughly. Finally, let X be the number of minutes from sunset to sunrise.

At Washington, D. C., the total radiation received per square centimeter horizontal surface during a clear day is,[2] in June, 732 calories, and in December, 241 calories. That is, numerically, in June $S'=732$, $C'=146$, and in December, $S'=241$, $C'=48$. In June, $X=600$, while in December, $X=880$. Hence in June, $S=-90$, $C=-30$, and in December, $S=-132$, $C=-44$. Thus, at Washington, in June, $S+S'=642$ and $C+C'=116$.

Therefore a cloud canopy, day and night, at Washington, D. C., would lower the temperature in June.

In December, $S+S'=109$, $C+C'=4$. Hence in December also a continuous cloud canopy would lower the temperature at this locality. At a somewhat higher latitude, however, probably around 50°, the cloud canopy would not change the temperature at this season, while at a still higher latitude it would raise the temperature.

As stated above, evaporation and condensation, and the circulation of air and water are very effective as distributors of heat. Therefore the boundary along which a cloud canopy would have no effect on the surface temperature is distorted irregularly in time and place by all these phenomena, as well as more or less uniformly shifted with the course of the seasons. Only continuous and direct observations can give us full information as to the places and times of the warming and the cooling of the surface of the earth—the places of net gain and net loss of heat by all processes combined. However, it does seem practically certain that a continuous cloud canopy over the entire earth would materially lower its average temperature. It would raise the temperature of polar and high latitude (beyond latitude 50°, roughly) winters, and lower the temperature at nearly all other times and places.

This qualitative result is, of course, unsatisfactory, but that appears to be all we can obtain at present with assurance.

[1] MONTHLY WEATHER REVIEW, 46, p. 57, 1918.

[2] Marvin and Kimball, Journal of the Franklin Institute, 202, p. 302, 1926.

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WINTER OF 1928–29 IN EUROPE

By W. R. STEVENS

[Weather Bureau, Washington, June, 1929]

The past winter has been one of the most severe that Europe has experienced since the inception of systematic meteorological observations. In Berlin, for example, the mean winter temperature was the lowest of record, with but one exception, 1829–30. There was but one day from December 8, 1928, to March 7, 1929, when the temperature was not below freezing. December was about 2° F. below normal, January 6° F. below, and February 20° F. below. Since 1851 there have been but six winters with all three months below normal. February, 1929, was the coldest since meteorological observations were begun at Berlin in 1720; the temperature of −13° F. observed on the morning of February 11, is the lowest of record. Lowest temperatures of record were also observed at Hamburg (−6° F.), Hannover (−13° F.), Frankfort on the Main (−7° F.), Frankfort on the Oder (−24° F.), Dresden (−18° F.), Leipzig (−17° F.), Breslau (−26° F.) Munich (−25° F.), and Vienna (−15° F.), the latter being the lowest since observations were begun in 1775.

During January pressure was above normal over western Europe and greatly above in the region of Iceland, Isafjord being 0.72 inch above, while Horta was 0.33 inch below. One of the most unusual features in January, 1929, was the fact that pressure averaged higher over Iceland than over Horta.

In February also the pressure distribution was very abnormal. Iceland and Horta returned to normal, or slightly above, but over Scandinavia the departures were as much as +0.60 inch, while departures in southern Europe were negative.

During the first few days of January a LOW of considerable intensity was central over the Mediterranean, which was accompanied by heavy rains and resulted in the worst flood on the Tiber since February, 1915. Cold weather and heavy snows occurred during the first half of the month quite generally over Europe as far south as the Riviera. In central Europe the snows were so heavy that railway and telegraph communications were broken in several places, the ice on the Elbe above Hamburg was so thick that the river could be crossed on foot, skating was permitted on the lakes in the Bois de Boulogne in Paris on the 17th and 18th for the first time since 1917.

The most severe period lasted from approximately January 21 to February 21. For about a week previous to the beginning of this period a HIGH of great intensity had been building up over Siberia in the Provinces of Irkutsk and Yakutsk, and began gradually spreading to the westward. On the morning of January 21st, high pressure extended from Japan to western Europe with a crest of 31.39 inches at Bratski-Ostrog in the Province of Irkutsk, which had advanced to western Russia, Perm, 31.16 inches, by the 24th. Pressure fell over southern and central Europe, a LOW of considerable intensity developing over the Mediterranean by the 25th, which moved eastward and on the 31st was central over Limasol, Cyprus, 29.59 inches. This LOW was attended by heavy snows as far south as the Riviera and severe cold and violent storms in Jugoslavia. In the meantime pressure remained high in Russia and Siberia, Leningrad, 31.03 inches; Chita, Trans-Baikal Province, 31.30 inches. By the morning of February 4 the Leningrad HIGH had